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(71) Applicant(s)

Basf Aktiengesellschaft
 (Incorporated in the Federal Republic of Germany)
 D-67056, Ludwigshafen, Federal Republic of Germany

(72) Inventor(s)

Frank Meyer
Hiroki Ishida
Peter Schuhmacher

(74) Agent and/or Address for Service

J Y & G W Johnson
 Kingsbourne House, 229-231 High Holborn, LONDON,
 WC1V 7DP, United Kingdom

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C253 C30Y C358 C36Y C364 C366 C368 C37X C491
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C4X X12 X12TP
U1S S1387

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WO 95/16007 A1

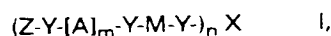
(58) Field of Search

Online: CAS ONLINE

(54) Abstract Title

Polymerizable chiral dopants based on chiral tetrahydrofuran or hexahydrofuro[3,2-b]furan substituted by at least two mesogenic groups

(57) Chiral compounds are disclosed of the formula



where, independently of one another,

A is a spacer,

M is a mesogenic group containing two phenylene radicals which are unsubstituted or substituted by C₁- to C₄-alkyl, methoxy, ethoxy, fluorine, chlorine, bromine, C₁- to C₂₀-alkoxycarbonyl or C₁- to C₂₀-alkylcarbonyl and are linked via O, CO, OCO, OCOO or COO,

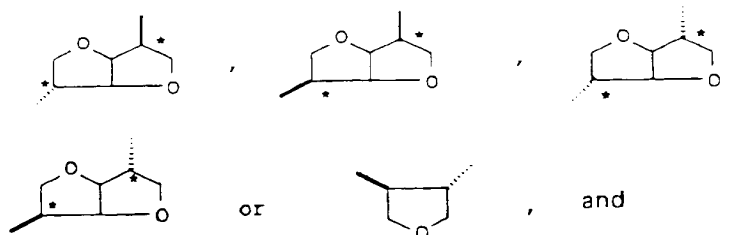
Y is a direct bond, O, S, COO, OCO, OCOO, CON(R) or N(R)CO, and

Z is a polymerizable group,

m is 0 or 1,

n is from 2 to 6, and

X is a chiral radical of the formula



R is C₁ to C₄ alkyl or hydrogen.

The compounds of the formula I are suitable as chiral dopants for liquid crystal displays.

The compounds of the formula I are also suitable as chiral dopants for cholesteric liquid crystals for use in optical polarizers and optical filters.

This patent has a priority claim based on German Patent Application No. 19 74 4321, filed 08.10.1997, and German Patent Application No. 19 74 4322, filed 08.10.1997, both of which are hereby incorporated by reference into this patent. With the formal requirements of the Patent Rules 1998.

GB 2 330 139 A

Polymerizable chiral compounds, and their use

- It is known that molecules which are anisotropic in shape can form liquid-crystalline phases, known as mesophases, on warming. The individual phases differ through the spatial arrangement of the major parts of the molecules on the one hand and through the molecular arrangement with respect to the long axes on the other hand (G.W. Gray, P.A. Winsor, Liquid Crystals and Plastic Crystals, Ellis Horwood Limited, Chichester 1974). The nematic liquid-crystalline phase is distinguished by the fact that there is only one alignment long-distance ordering due to the long molecular axes lining up in parallel. Under the prerequisite that the molecules making up the nematic phase are chiral, a cholesteric phase forms, in which the long axes of the molecules form a helical superstructure perpendicular thereto (H. Baessler, Festkörperprobleme XI, 1971). The chiral moiety may be present either in the liquid-crystalline molecule itself or added to the nematic phase as a dopant. Phases produced by doping are referred to as induced cholesteric phases. This phenomenon was first studied on cholesterol derivatives (H. Baessler, M.M. Labes, J. Chem. Phys. 52 (1970) 631; H. Baessler, T.M. Laronge, M.M. Labes, J. Chem. Phys. 51 (1969) 3213; H. Filkelmann, H. Stegemeyer, Z. Naturforschg. 28a (1973) 799). It later also became possible to induce cholesteric phases by adding other chiral substances which are not themselves liquid-crystalline (H. Stegemeyer, K.J. Mainusch, Naturwiss. 58 (1971) 599; H. Finkelmann, H. Stegemeyer, Ber. Bunsenges. Phys. Chem. 78 (1974) 869).
- The cholesteric phase has remarkable optical properties: large optical rotation and pronounced circular dichroism caused by selective reflection of circular-polarized light within the cholesteric layer. The different colors observed depending on the veering angle depend on the pitch of the helical superstructure, which is itself dependent on the twisting power of the chiral component. The pitch and thus the wavelength range of the selectively reflected light of a cholesteric layer can be varied, in particular, by changing the concentration of a chiral dopant (J.E. Adams, W.E.L. Haas, Mol. Cryst. Liq. Cryst. 16 (1972) 33).
- Such cholesteric systems offer interesting opportunities for practical use. Thus, incorporation of chiral moieties into mesogenic acrylic esters after alignment in the cholesteric phase and photocrosslinking allows the production of a stable, colored polymer. (J.E. Adams, W.E.L. Haas, Mol. Cryst. Liq. Cryst. 16 (1972) 33; J.E. Adams, W.E.L. Haas, J. Polym. Sci. Polym. Chem. Ed. 18 (1980) 289). Furthermore, admixing of non-crosslinkable, chiral compounds with nematic acrylic esters

allows, after photocrosslinking, the production of a colored polymer (I. Heyndericks, D.J. Broer, Mol. Cryst. Liq. Cryst. 203 (1991) 113), but this still contains volatile constituents which are prohibitive for use.

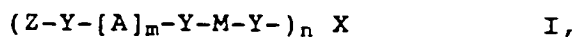
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EP-A-739403 describes chiral compounds which firstly have a high twisting power and secondly can be incorporated into the cholesteric phase in a stable manner in any desired concentration without diffusing or crystallizing out of the phase.

10

We have now found a group of compounds which has even better properties than those described above.

Accordingly, the present invention provides compounds of the
15 formula I



where, independently of one another,

20

A is a spacer,

M is a mesogenic group containing two phenylene radicals which are unsubstituted or substituted by C₁- to C₄-alkyl, methoxy, ethoxy, fluorine, chlorine, bromine,
25 C₁- to C₂₀-alkoxycarbonyl or C₁- to C₂₀-alkylcarbonyl and are linked via O, CO, OCO, OCOO or COO,

Y is a direct bond, O, S, COO, OCO, OCOO, CON(R) or N(R)CO, and

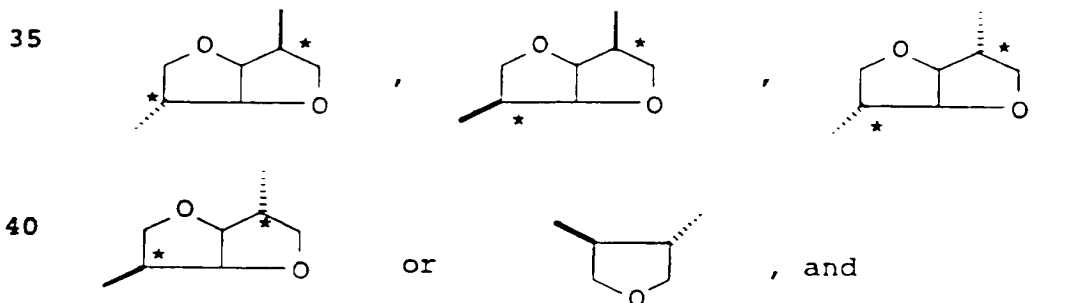
Z is a polymerizable group,

30

m is 0 or 1,

n is from 2 to 6, and

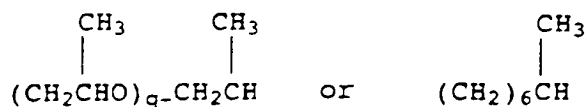
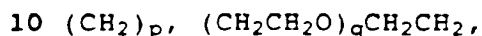
X is a chiral radical of the formula



R is C₁- to C₄-alkyl or hydrogen.

The spacer A can be any group known for this purpose; the spacers are usually linked to X via ester or ether groups or a direct bond. The spacers generally contain from 1 to 30, preferably from 1 to 12, carbon atoms and may be interrupted in the chain by, for example, O, S, NH or NCH₃. Suitable substituents for the spacer chain are fluorine, chlorine, bromine, cyano, methyl and ethyl.

Examples of representative spacers are the following:



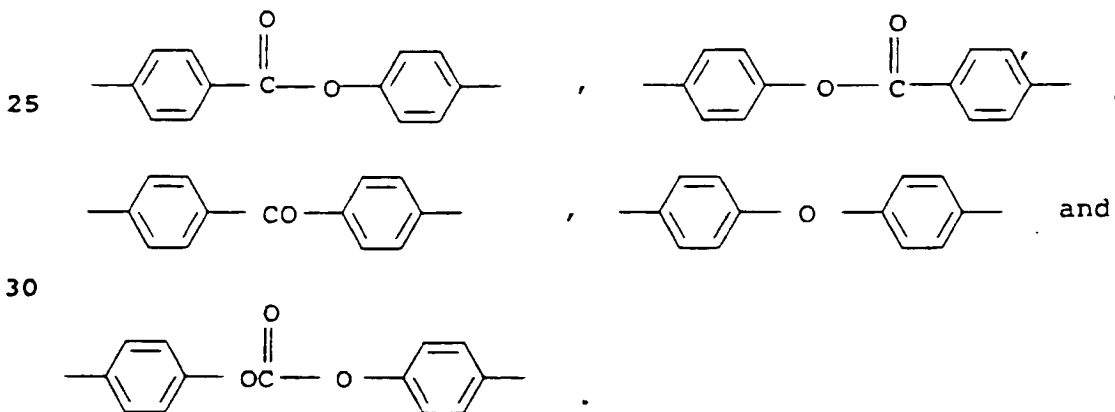
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where

p is from 1 to 12, and

q is from 1 to 3.

20 Particularly preferred mesogenic groups M are, for example:



35

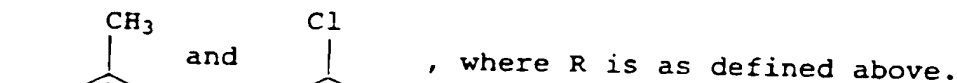
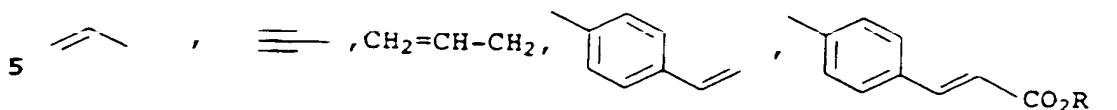
The groups necessary for the novel compounds are linked to one another via bridges Y, such as O, S, COO, OCO, OCOO, CONH, NHCO, CON(R), N(R)CO or a direct bond, where R is C₁- to C₄-alkyl or hydrogen. Y is preferably O, OCO, COO or OCOO.

40

n is preferably 2.

45 compounds, vinyl ethers and styrene derivatives. Epoxides are also suitable.

Examples of preferred radicals Z are the following:



Z is particularly preferably $\text{CH}_2=\text{CH}-$, $\text{CH}_2=\text{C}-$ or $\text{CH}_2=\text{CH}-\text{CH}_2-$.

15 The units $\text{Z}-\text{Y}[\text{A}]_m-\text{Y}-\text{M}-\text{Y}$ according to the invention, where Z, Y, m, A and M are as defined above, can be obtained by generally known synthetic methods, as described, for example, in EP-A 739403 and DE-A 39 17 196.

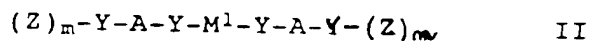
20 The chiral moieties can be purchased commercially and are thus available.

The novel compounds are suitable as high-twisting-power dopants for producing cholesteric liquid crystals. Using very small
25 amounts, the reflection wavelength of the cholesteric mixture can be shifted into the visible region. It is advantageous here that the dopants form a stable mixture with the nematic host system, from which mixture the dopant does not crystallize out. The novel compounds are particularly suitable for this purpose.

30 The novel compounds are particularly suitable for use in electro-optical display elements or as chiral dopants for nematic or cholesteric liquid-crystal mixtures for producing layers which reflect in color.

35 The novel compounds are also suitable for use as chiral dopants in optical polarizers and optical filters.

Particular preference is given here to mixtures of the novel
40 compounds with nematic compounds of the formula



Compounds of the formula II are described, for example, in DE-OS 195 32 408, GB-A-22 79 659, (EP-A-749 466) and EP-A-648 827.

5 Also claimed are solid compositions comprising the novel compounds in copolymerized form.

Also claimed are solid compositions comprising the novel compounds and nematic compounds of the above formula II, in each
10 case in copolymerized form.

Solid compositions of this type may be, for example, polymers which can contain partly uncrosslinked or non-copolymerized constituents. Non-copolymerized constituents of this type can be,
15 for example, unreactive organic molecules having a wide variety of molecular weights or alternatively inorganic or organic pigments. They may furthermore also be additives, for example rheology auxiliaries or light and/or oxidation stabilizers.

20 It is of course also possible for solid compositions of this type to be the polymerization products of the claimed liquid-crystalline mixtures containing the novel compounds, and of the claimed liquid-crystalline mixtures containing nematic compounds of the above formula II in addition to the novel compounds.

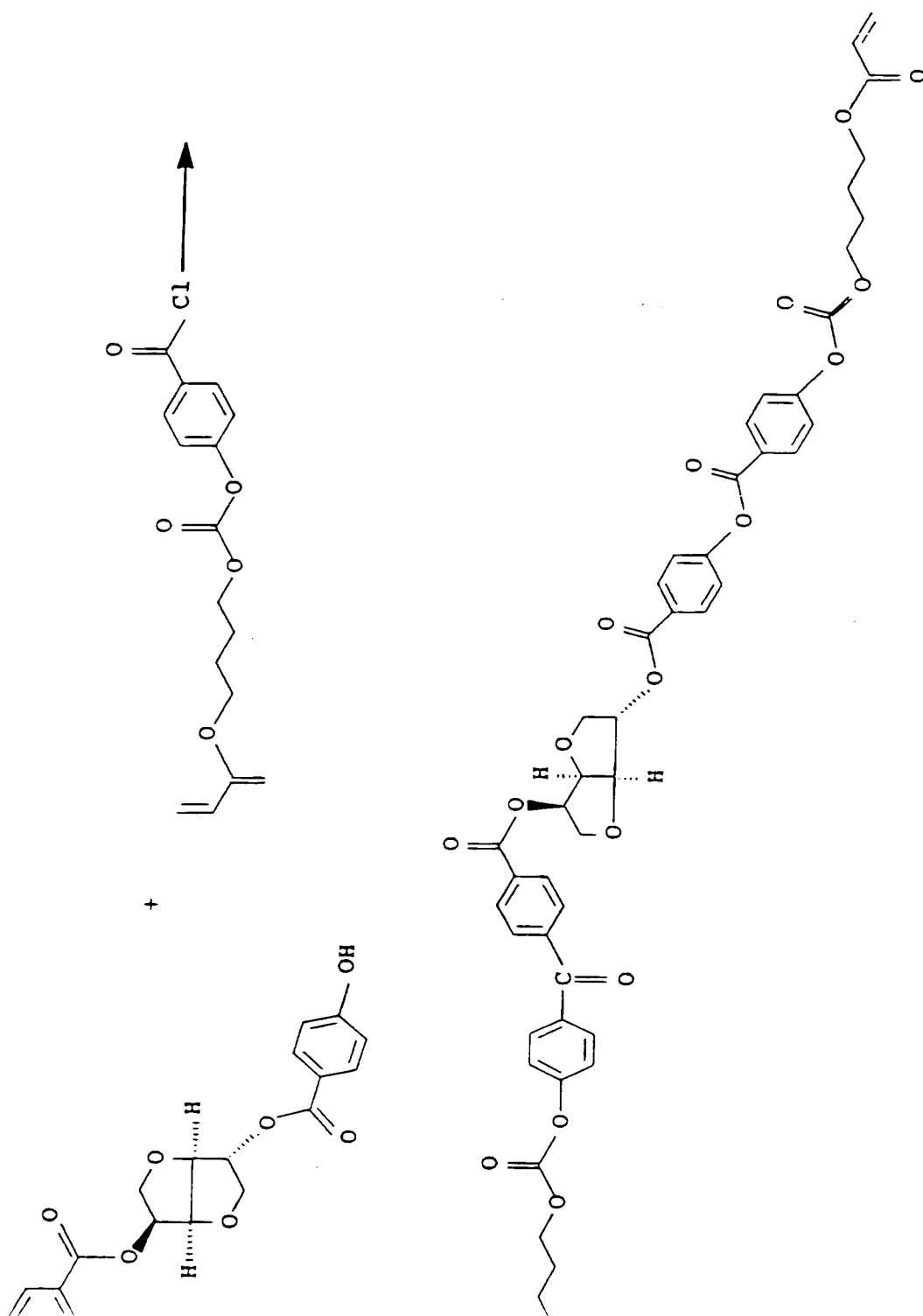
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Exap.
H



Proce-

3.84 g 1 mol) of bis(4'-hydroxybenzoyl)-1,4:3,6-dianhydroorbitol are dissolved in 30 ml of DMF and
5.08 04 mol) of N,N-dimethylcyclohexylamine, and 8.0 g (0.024 mol) of 4-acryloxybutoxycarbonyl-
oxyben chloride are then added dropwise at 0 - 5°C. The mixture is stirred at 0-5°C for one hour,
at 40° 3 hours and then at RT overnight. The reaction mixture is poured into water and acidified
using hydrochloric acid. Ethyl acetate is added, and the organic phase is washed with water,
dried sodium sulfate and evaporated in a rotary evaporator.

Yield 3 g

The product is chromatographed over 1.1 kg of silica gel using the eluent petroleum ether/ethyl
acetate (1).

Yield g (96%) [NMR]

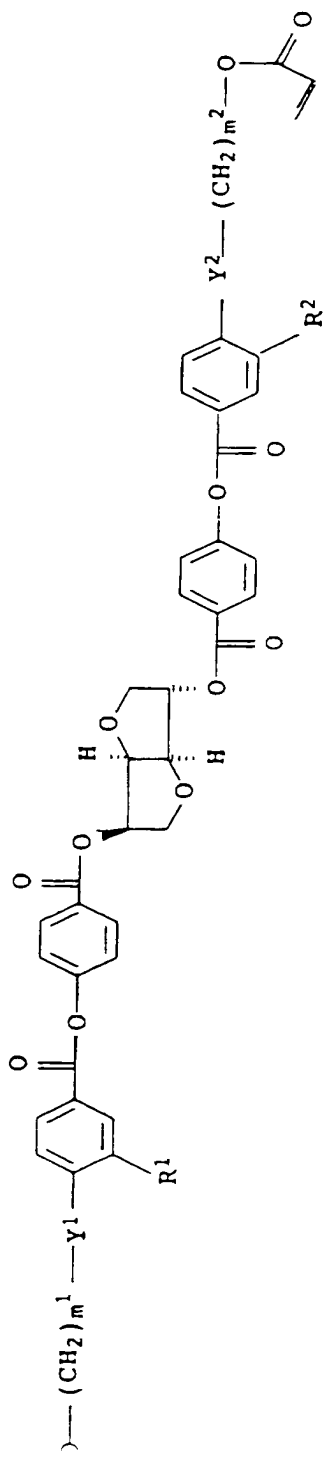
HTP 1840 63 μm^{-1}

Melt 109°C (DTA)

The compound has a right-handed twist.

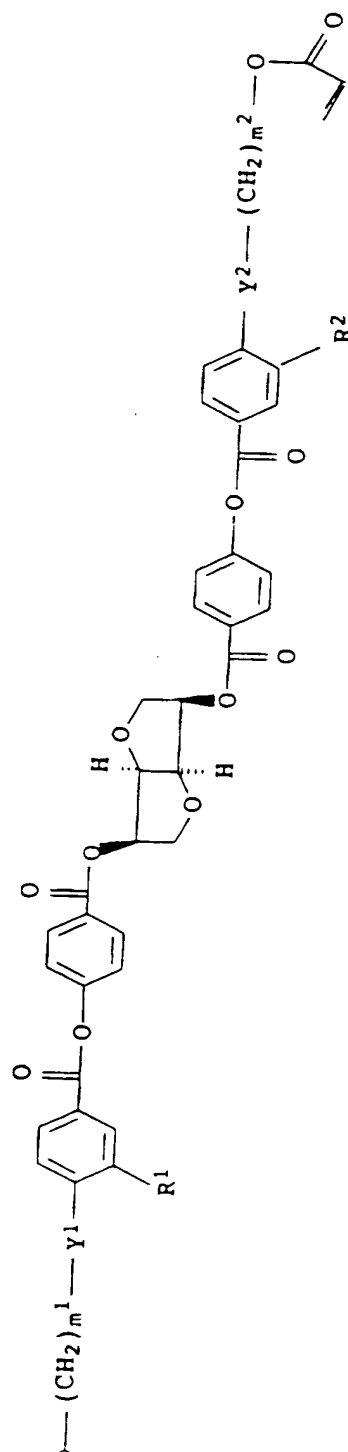
Further compounds prepared by this and similar processes are the following:

HTP local twisting power

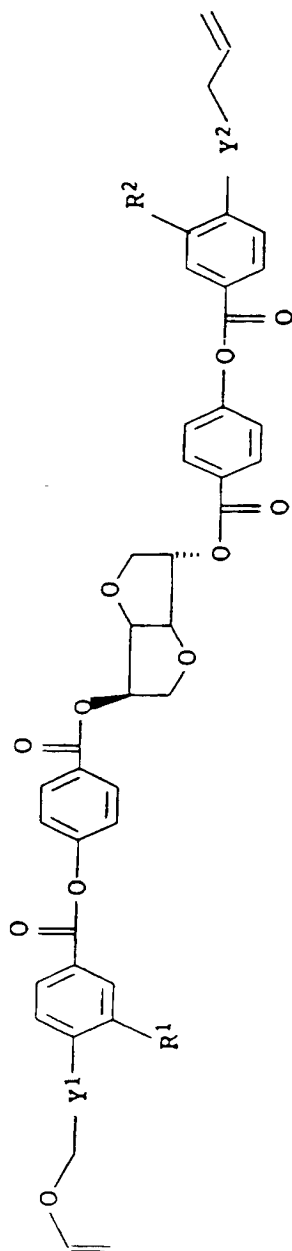


Ex.	Y ²	R ¹	R ²	m ¹	m ²	HTP ¹ μm ⁻¹ in ZLI 1840	Twist
2	OCOO	OMe	OMe	2	4		right-handed
3	OCOO	OMe	OMe	4	4	50	right-handed
4	OCOO	OMe	OMe	6	6		right-handed
5	OCOO	OMe	OMe	4	6		right-handed
6	OCOO	OMe	OMe	6	4		right-handed
7	OCOO	H	H	2	2		right-handed
8	OCOO	H	H	4	2		right-handed
9	OCOO	H	H	2	4		right-handed
10	OCOO	H	H	6	6		right-handed
11	OCOO	H	H	6	4		right-handed
12	O	H	H	2	2		right-handed
13	O	H	H	4	2		right-handed
14	O	H	H	4	4	63	right-handed
15	O	H	H	4	6		right-handed
16	O	H	H	6	6		right-handed
17	OCOO	H	H	4	4		right-handed
18	OCOO	H	H	4	4		right-handed
19	O	H	H	6	6		right-handed

Ex	Y ¹	Y ²	R ¹	R ²	m ¹	m ²	HTP μm-1 in ZLI 1840	Twist
20		OCOO	H	H	6	6		right-handed
21	OCOO	COO	H	H	4	4		right-handed
22	COO	COO	H	H	6	6		right-handed
23	CO	O	H	H	4	4		right-handed
24	CO	O	H	H	6	6		right-handed



Ex.	Y ²	R ¹	R ²	m ¹	m ²	HTP μm^{-1} in ZLI 1840	Twist
25	OO	OMe	OMe	4	4	11	left-handed
26	OO	OMe	OMe	6	6		left-handed
27	OO	OMe	OMe	2	2		left-handed
28	O	H	H	2	2		left-handed
29	O	H	H	4	2		left-handed
30	O	H	H	4	4	63	left-handed
31	O	H	H	6	6		left-handed
32	OCO	H	H	2	2		left-handed
33	OCO	H	H	4	4		left-handed
34	OCO	H	H	6	6		left-handed
35	OCO	H	H	6	4		left-handed
36	OO	H	H	2	2		left-handed
37	OCO	H	H	2	4		left-handed
38	OCO	H	H	4	4	13	left-handed
39	OCO	H	H	6	6		left-handed
40	OCO	H	H	4	6		left-handed
41	OCO	H	H	6	4		left-handed
42	O	OMe	OMe	4	4		left-handed



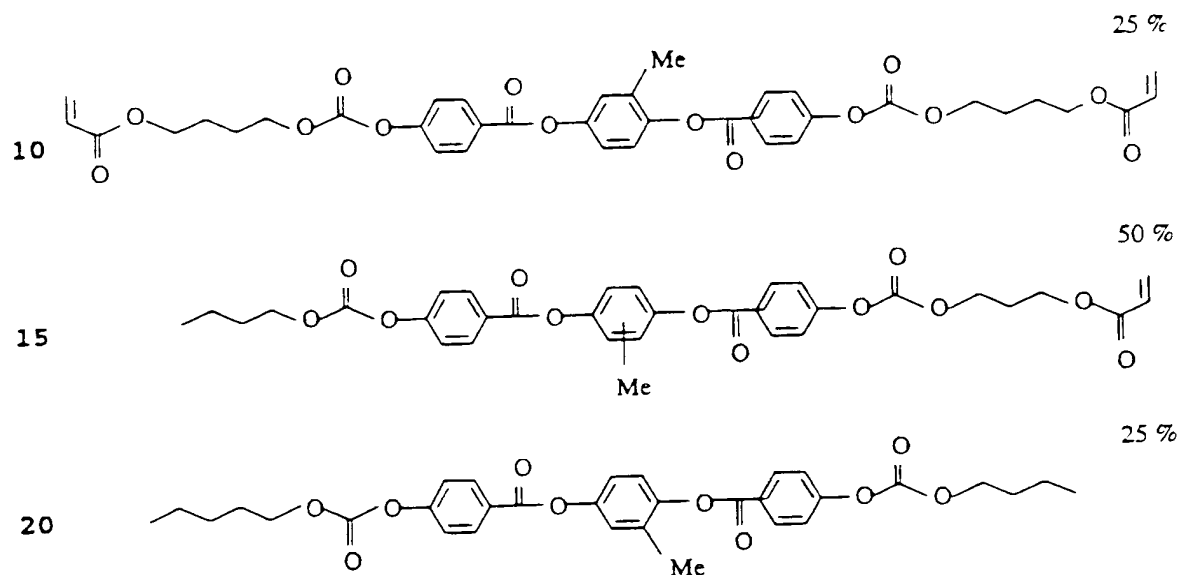
Ex
43
44
45
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48

1	Y ²	R ¹	R ²
	O	H	H
	O	OMe	OMe
	O	Me	Me
COO	OCOO	H	H
CO	OCO	H	H
CO	OCO	H	H

Mixtures with liquid-crystalline substances

Example 49

5 x mol% of Example 1 are dissolved in the nematic mixture



by mixing the melts. After cooling to RT, cholesteric phases with the following reflection wavelengths - depending on X - are

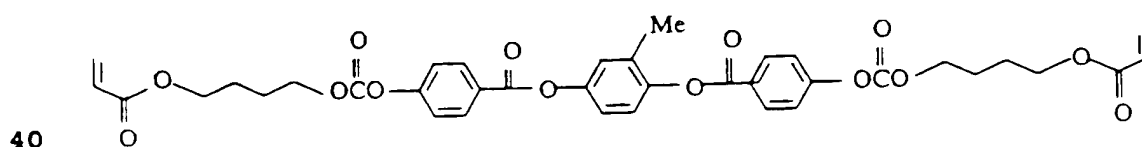
25 obtained:

x (mol%)	λ_{\perp} (nm)
2.0	701
3.0	482
4.0	341

Example 50

x mol% of Example 1 are dissolved in the nematic compound

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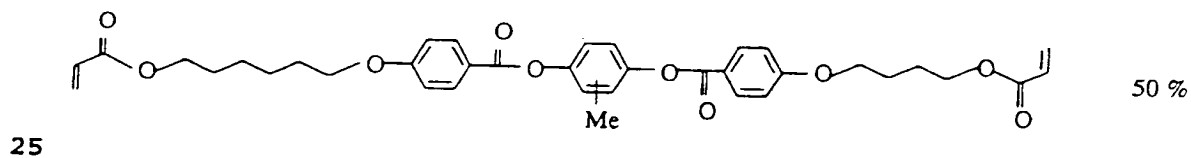
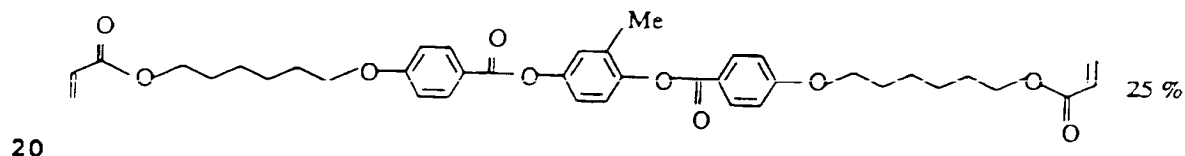
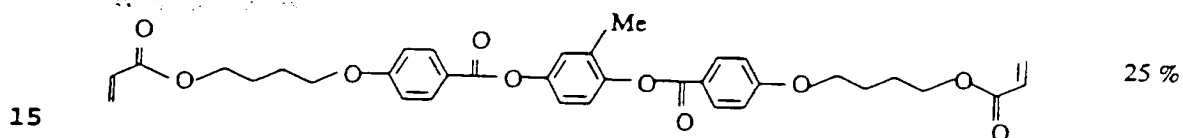


45

x (mol%)	λ_{\perp} (nm)
3.05	660
3.51	565
5 4.28	465
5.46	365

Example 51

10 x mol% of Example 1 are dissolved in the nematic mixture



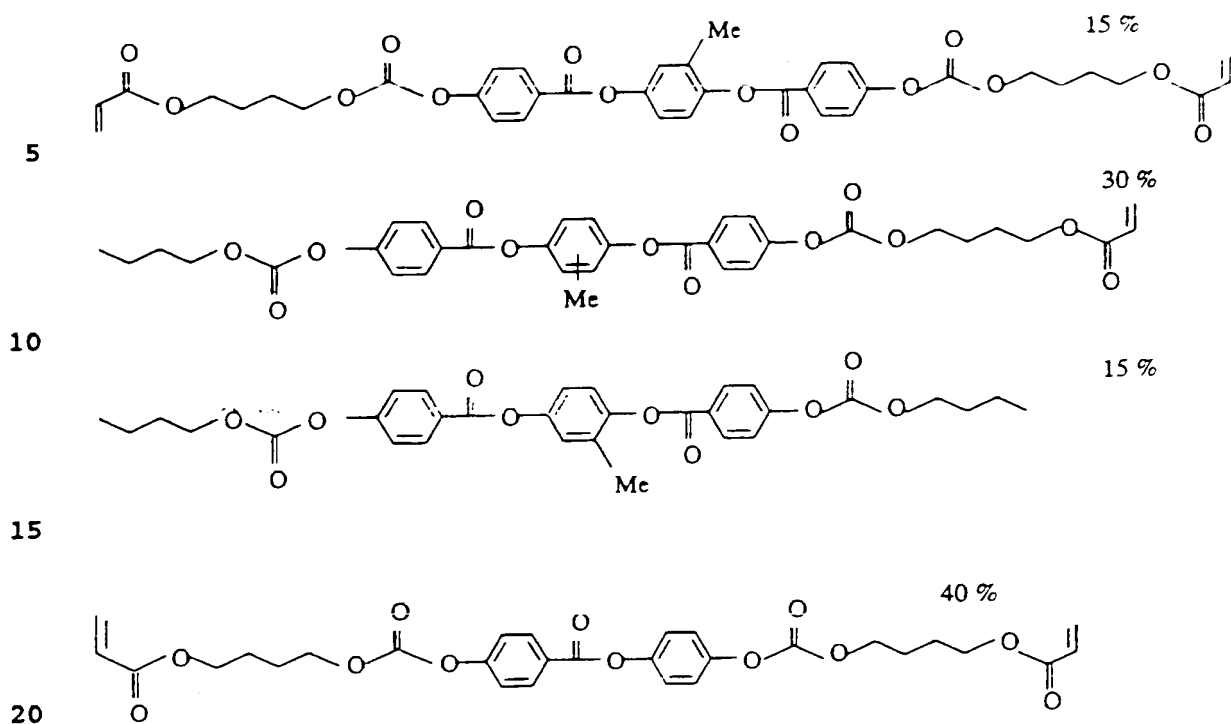
by mixing the melts. After cooling to RT, cholesteric phases with the following reflection wavelengths - depending on X - are obtained:

30

x (mol%)	λ_{\perp} (nm)
2.0	854
2.5	696
3.0	575
35 3.5	498

Example 52

40 x mol% of Example 1 are dissolved in the nematic mixture

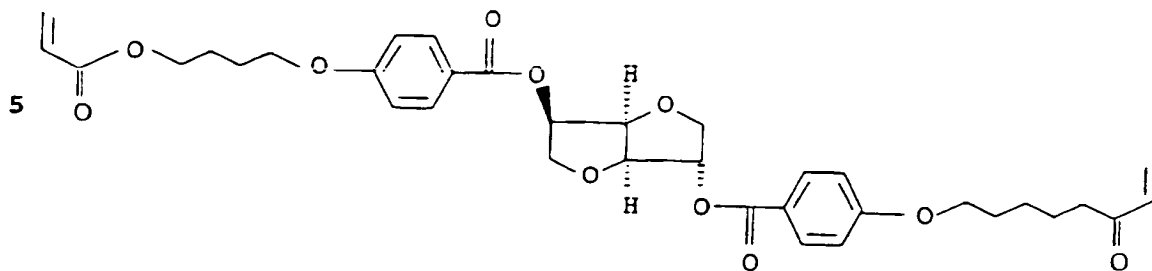


by mixing the melts. After cooling to RT, cholesteric phases with the following reflection wavelengths - depending on X - are obtained:

x (mol%)	λ_{\perp} (nm)
1.5	974
2.0	736
2.5	588
3.0	493

Comparative Example 53

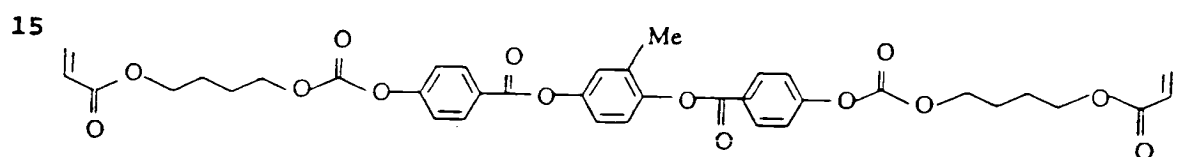
4 mol% of both the compound from Example 1 and the compound of the formula III (corresponding to EP-A-739 403)



10

III

are added to the nematic compound



15

20 The two substances are melted and their spectrum measured at RT. The compound from claim 1 gives a reflection at 431 nm, while the compound of Formula III gives a reflection at 1087 nm.

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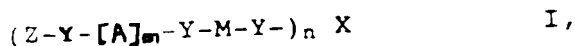
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Claims

1. A compound of the formula

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where, independently of one another,

10

A is a spacer,

M is a mesogenic group containing two phenylene radicals which are unsubstituted or substituted by C₁- to C₄-alkyl, methoxy, ethoxy, fluorine, chlorine, bromine, C₁- to C₂₀-alkoxycarbonyl or C₁- to C₂₀-alkylcarbonyl and

15

Y is a direct bond, O, S, COO, OCO, OCOO, CON(R) or N(R)CO, and

Z is a polymerizable group,

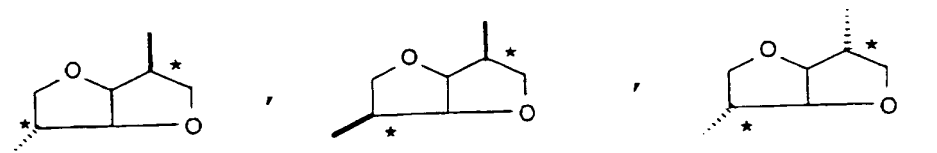
m is 0 or 1,

20

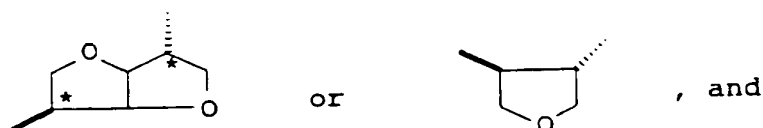
n is from 2 to 6, and

X is a chiral radical of the formula

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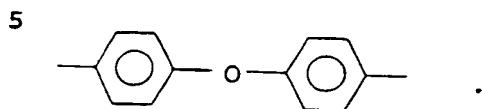
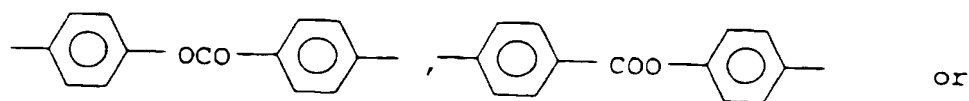
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R is C₁- to C₄-alkyl or hydrogen.

2. A compound as claimed in claim 1, where n = 2.

3. A compound as claimed in claim 1, where M is

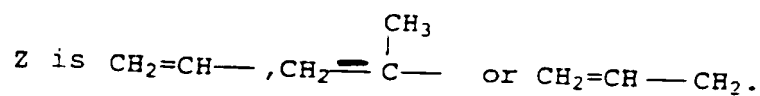
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10 4. A compound as claimed in claim 1, where

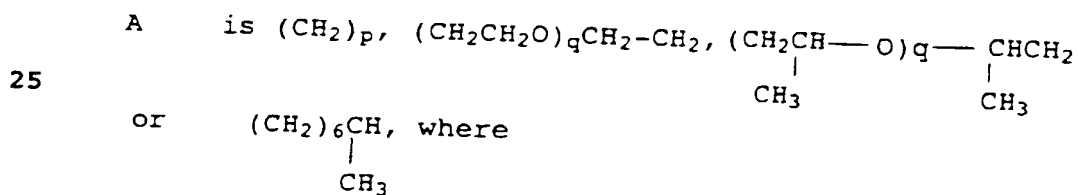
Y is O, OCO, COO, OCOO or a direct bond.

15 5. A compound as claimed in claim 1, where



20

6. A compound as claimed in claim 1, where

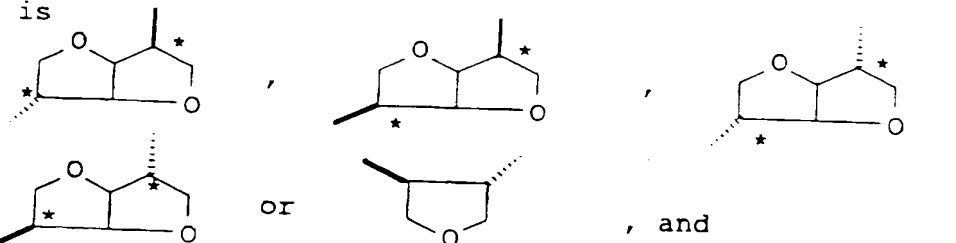


30 P is from 1 to 12 and q is from 1 to 3.

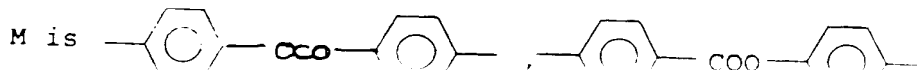
7. A compound as claimed in claim 1, where

35

X is



40



8. A compound as claimed in claim 1 and referred to in any of the foregoing Examples 1 to 52.
9. A liquid-crystalline mixture comprising one or more compounds as claimed in any of claims 1 to 8.
- 5 10. A liquid-crystalline mixture comprising one or more compounds as claimed in any of claims 1 to 8 and one or more nematic compounds of the formula II
$$(Z)_n-Y-A-Y-M^1-Y-A-Y-(Z)_m,$$
II
where, in each case independently of one another, A, m, Y and Z are as defined in claim 1, and M¹ is a mesogenic group.
10
11. A solid composition comprising a compound as claimed in any of claims 1 to 8 in copolymerized form.
12. A solid composition comprising a compound as claimed in
15 any of claims 1 to 8 and a nematic compound of the formula II defined in claim 10, in each case in copolymerized form.
13. The use of a compound as claimed in any of claims 1 to 8
20 in electro-optical displays or as a chiral dopant for nematic or cholesteric liquid crystals for producing layers which reflect in color.
14. The use of a compound as claimed in any of claims 1 to 8 as a chiral dopant in optical polarizers and optical filters.



Application No: GB 9821817.5
Claims searched: 1-14

Examiner: Stephen Quick
Date of search: 8 January 1999

Patents Act 1977 Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:
UK CI (Ed.Q): (not searched)
Int CI (Ed.6): (not searched)
Other: Online: CAS ONLINE

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	WO 95/16007 A1 (BASF), see pages 3 (lines 1-11), 4 (lines 40-end), 5 (lines 1-17) & 8 (lines 33-42); acknowledged in this application as EP 0739403	-

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| <p>Document indicating lack of novelty or inventive step</p> <p>Y Document indicating lack of inventive step if combined with one or more other documents of same category</p> <p>& Member of the same patent family</p> | <p>Document indicating technical problem solved</p> <p>Document published on or after the declared priority date but prior to the filing date of this invention</p> <p>E Patent document published on or after, but with priority date earlier than, the filing date of this application</p> |
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